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ABSTRACT

Chemical repellents derived from predators might offer more effective and longer lasting protection from vertebrate depredations than current damage control measures. Thus, we conducted laboratory and field studies to evaluate the repellency of mongoose feces and urine to black rats *(Rattus rattus)* and Polynesian rats *(R. exulans)*. We exposed captive wild rats to water, butyric acid, mongoose *(Herpestes auropunctatus)* feces, or mongoose urine in a 150- × 60- × 120-cm partitioned arena and recorded their behavior with a video camera. None of the test substances had any apparent effect ($P>0.05$) on behavior or the percentage of observations spent (1) in the transfer cage, (2) in tunnels, (3) on the side of the arena with the treatment, (4) in, on, or near the tunnel with the treatment, or (5) in the tunnel with the treatment. Nor did we observe any effect on latency until rats emerged from the transfer cage or entered the treated tunnel or time spent in the treated tunnel during their first visit. During the field test, we set and monitored 50 pairs of live traps along each of 12 transects in forested areas and along the perimeter of recently harvested sugarcane fields. Mongoose feces or urine was applied to one trap in each pair. We captured 49.2 rats *(R. rattus* and *R. exulans)* per transect during 4 nights of trapping. We captured fewer ($P<0.05$) rats in traps soiled with mongoose feces than traps soiled with mongoose urine or unsoiled traps. The gender of the mongoose that was the source of the feces or urine had no effect ($P>0.05$) on capture success. The discrepancy between the laboratory and field studies indicates that researchers should incorporate relevant factors in the natural environment into their test paradigm and interpret the results of tests with captive animals cautiously. Additional research is warranted to determine the active compound(s) in mongoose feces that repel rats and to explore the use of such compounds to reduce rat damage to agricultural crops.

KEY WORDS

feces, Herpestes auropunctatus, predator odors, Rattus exulans, Rattus rattus, repellency, semiochemicals, urine

INTRODUCTION

Rats (*Rattus* spp.) cause a myriad of economic (Dubock 1984), health (Gratz 1988), and ecological (Moors et al. 1992) problems throughout the world. Rodenticides frequently are the only practical control method (Jackson 1987, Myllymäki 1987). Many rodenticide baiting programs fail, however, because of neophobia, sublethal aversion to the poison bait, genetic or physiological resistance, and rapid reinvasion of depopulated areas (Barnett 1988, Prakash 1988).

Chemical repellents derived from predators might provide more effective and longer lasting relief from some rodent problems (Mason et al. 1994). Many animals have an innate or learned fear of predators that might be exploited to reduce crop damage. Researchers have used predator odors to protect a variety of crops from damage by pocket gophers *(Thomomys talpoides)* (Sullivan et al. 1988*a*, 1990*b*), voles *(Microtus* spp.) (Sullivan et al. 1988*b*, 1990*a*; Merkens et al. 1991), house mice *(Mus musculus)* (Coulston et al. 1993), snowshoe hares *(Lepus americanus)* (Sullivan et al. 1985, Sullivan 1986), woodchucks *(Marmota monax)* (Swihart 1991), deer *(Odocoileus hemionus)* (Müller-Schwarze 1972, Melchiors and Leslie 1985), elk *(Cervus elaphus)* (Andelt et al. 1992), sheep *(Ovis aries)* (Arnould and Signoret 1993), and mountain beavers *(Aplodontia rufa)* (Epple et al. 1993, Nolte et al. 1993). Repellents are nonlethal and thus would have minimal nondesirable environmental effects.

In Hawaii, rats cause extensive damage to growing sugarcane (Tobin et al. 1990, Tobin and Sugihara 1992) and macadamia nuts (Tobin 1992, Tobin et al. 1993). Zinc phosphide, the only rodenticide registered for use in Hawaiian agricultural crops, provides only marginal protection (Sugihara et al. 1995). Predator-derived repellents may provide an alternative means of reducing damage.

Hawaiian sugarcane growers introduced the small Indian mongoose into Hawaii in the 1880's to reduce damage by rats. Mongooses have not eliminated rat depredations, but today they are a major predator of rats in Hawaii (Baldwin et al. 1952, Kami 1964). Mongooses are ubiquitous on all the main Hawaiian islands except Kauai, and they frequently enter traps that are set for rats. Rats avoid traps that have previously captured mongooses (Tobin et al. 1995), indicating that residual trap odors left by mongooses repel rats.

In this paper, we describe laboratory and field studies that investigated the repellency of mongoose feces and urine to rats. Our objectives were to determine whether (1) captive rats display antipredator behavior or otherwise reacted to the presence of mongoose urine or feces and (2) capture success of wild rats is lower in live traps soiled with mongoose urine or feces.

METHODS

Laboratory Study

Capture and Maintenance of Animals

We captured black rats, Polynesian rats, and mongooses in Haguruma® wire cage traps baited with chunks of coconut in forested areas near Hilo, HI. We checked traps daily and transported captured animals to the Denver Wildlife Research Center's (DWRC) field station in Hilo, HI. Rats were dusted with carbaryl powder, housed individually in indoor 36- × 18- × 18-cm stainless steel wire-mesh cages, and offered laboratory chow ad libitum for ≥21 days before testing. We likewise dusted 8 mongooses (4 of each gender) with carbaryl powder and housed them individually in a separate room in 43- × 25- × 18-cm stainless steel wire-mesh cages that had a solid back and sides. Each mongoose was offered one rat carcass daily. Both animal rooms had an ambient temperature of 25 °C and a 12-hr light/12-hr dark cycle. All animals had free access to water.

Arena

The stainless steel rectangular arena encompassed 150 × 60 × 120 cm (Figure 1). A partition with a 15- × 15-cm opening divided the arena in half. The arena was open at the top and bottom and rested on a laminated sheet of plastic. A 15- × 15-cm opening allowed rats to enter from a transfer cage and advance to either side of the arena. A sliding stainless steel door controlled access to the arena from the transfer cage. We placed a 30- × 10- × 10-cm stainless steel rectangular tunnel on each side of the arena near the back corner farthest from the opening to the transfer cage. Each tunnel had an open end that faced the rear of the arena and a closed end that contained a ceramic bowl with a chunk of coconut.

We recorded rat activity with a JVC® video camera (Model BY–1100), a Hitachi video cassette recorder (Model VTM151A), and a Hitachi television (Model CT2033B). The camera was positioned directly above the arena on a tripod atop an adjacent stainless steel table. The field of view of the camera encompassed the entire arena floor area. We clamped a lamp with a 40-W incandescent light bulb and a red cellophane filter to the top of either side of the arena. A cable connected the camera to a recorder and a television outside of the arena room.

Treatments

We evaluated the responses of rats to two predator odors (male mongoose urine and male mongoose feces); a novel, nonbiological odor (butyric acid); and water. We collected urine and feces from trays under the cages of four male mongooses. We pooled the urine collected from the four animals and stored it in a sealed flask at 20 °C. We pooled and stored the feces in a plastic bag at -10 °C. We mixed butyric acid (99%, Sigma Chemical Company, St. Louis, MO) with mineral oil and stored it at room temperature.

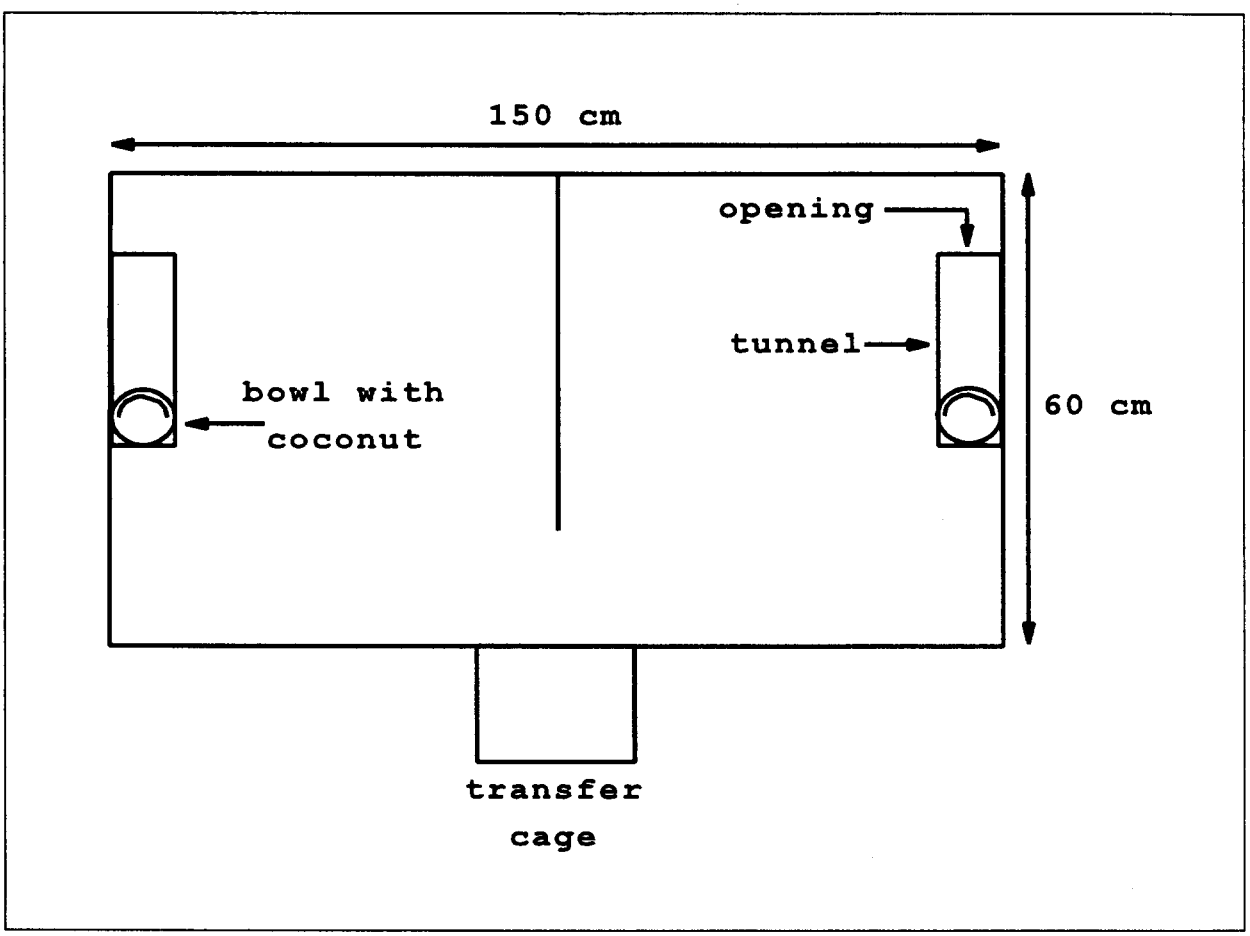

FIGURE 1. Schematic of stainless steel arena used to evaluate the repellency of mongoose *(Herpestes auropunctatus)* feces and urine to captive wild rats *(Rattus rattus* and *R. exulans)*. The walls and incomplete partition were 120 cm tall. Rats had free access to two tunnels that each contained a bowl with a chunk of coconut. During treatment trials, one of the bowls was treated with water, mongoose feces, mongoose urine, or butyric acid.

Within 5 min of the beginning of each trial, we applied the test materials to clean ceramic bowls as follows. We combined 0.75 g of thawed male mongoose feces with 5–10 drops of water in a petri dish under a fume hood. We used a cotton swab to smear the resulting slurry around

the lip of the bowls. For the urine, water, and butyric acid treatments, we used a pipette and cotton swab to deposit and spread 10 drops around the lip of the bowls.

Test Procedures

We randomly assigned 5 rats of each species and gender to each of 4 groups (40 rats total for each species). We tested half of the animals in each group (either three males and two females or two males and three females) during the first phase of the test and the remaining animals during the second phase.

Each test consisted of four 15-min trials conducted on consecutive days. During the first two trials, we preexposed rats to the arena and test procedures but did not collect data. During the third (pretreatment) trial, we recorded rats' behavior when both bowls were treated with water. During the fourth (treatment) trial, we exposed rats to one of the four test substances on one side (treated side) of the arena and water on the other. For each group, we randomly selected the side of the arena where we placed the test substance during the first phase and placed the test substance on the other side during the second phase. We evaluated only one substance per day to minimize residual odor effects among groups.

Immediately preceding each trial, we weighed three coconut chunks. We placed one chunk of coconut in each test bowl and the third chunk in a bowl on the table adjacent to the arena. The third chunk served as a control to measure weight changes due to moisture loss or gain. Immediately after each trial, we reweighed the coconut.

At 1600 hr on the day before each trial, we removed the laboratory chow from the cage of each rat that was to be tested the following day. Just prior to testing, we transported the test animal in its cage to the arena. We slid the cage into a pair of sleeves on either side of the arena entrance, which was blocked by a sliding door. We covered the cage with a stainless steel shield, turned on the video camera, and left the room. After allowing the animal to acclimate for 3 min, we reentered the room, slid open the door to the arena, and left the room. We recorded the rat's behavior for 15 min. At the end of the trial, we channeled the rat back into its cage, transferred it back to the animal room, and replaced its maintenance food.

After each trial, we washed the arena with chlorine bleach, detergent, and water, rinsed it with plain water, sprayed it with ethyl alcohol, and wiped it with a disposable wipe. We soaked the tunnels, food bowls, and cage cover in chlorine bleach, detergent, and water for 5 min and rinsed them with water. We turned on the air conditioner between trials to remove any residual odors.

We used a digitizing tablet and microcomputer to record the location, movement, and activity of each rat at 10-sec intervals from the video tapes. We thus recorded 90 observations per trial for each animal.

Statistical Analyses

We used a three-factor repeated measures ANOVA with trial as a repeated factor to detect differences among treatment groups and between male and female rats with regard to the percentage of observations that rats were (1) in the transfer cage, (2) in tunnels, (3) on the side

of the arena with the treated bowl, (4) in, on, or within a body length (excluding tail) of the treated tunnel, and (5) in the treated tunnel. We also analyzed (1) the time elapsed until rats emerged from the transfer cage, (2) the time elapsed until rats entered the treated tunnel, and (3) the time that rats remained in the treated tunnel during their first visit there. Finally, we compared various behaviors among groups. For the behavioral observations, we excluded records of rats that were in a tunnel or the transfer cage (and thus not visible to the camera), and for which we could not distinguish behaviors.

Field Study

We established 12 transects in forested areas and along the perimeter of recently harvested sugarcane fields near Hilo, HI. Each transect contained 50 pairs of Haguruma wire cage traps spaced 30 m apart; traps within each pair were 10 m apart.

We scattered grated coconut at each trap site 3–4 days before baiting the traps with chunks of coconut and setting them for 4 consecutive nights. We checked the traps before 1200 hr each morning and recorded the transect, trap location, and date of all captures. We transferred captured animals in their traps to the DWRC Hawaii field station for identification of species and sex and euthanasia with CO_2. We replaced traps that captured animals with clean traps set $\geq$2 m from the original trap site.

We used the same methods described in the laboratory study to collect and store feces and urine from captive mongooses. We pooled the feces and urine by the gender of the source animal.

We evaluated only one material per transect, either feces or urine applied to one trap in each pair. We placed 20–25 ml (a heaping tablespoon) of feces inside selected traps or used a syringe to apply 2 cc of urine to a 2-cm^2 piece of sponge suspended from the top of the trap. We randomly selected a trap position (right or left) for application of the treatment in odd-numbered pairs and applied the treatment to the other position in even-numbered pairs.

Statistical Analyses

We conducted a four-factor repeated measures ANOVA with treatment and trap day as repeated factors to determine whether rat captures varied with scent-type (mongoose feces or urine) or scent-sex (male or female mongoose). We used Duncan's multiple range test with an experiment-wise error rate of 0.05 to make pairwise multiple comparisons.

RESULTS

Laboratory Study

Black Rats

We detected little difference between trials, among treatment groups, or between gender of black rats with respect to the percentage of observations spent in various parts of the arena (P =

0.27 - 0.95) (Table 1) or to latency until rats emerged from the transfer cage, latency until they entered the treated tunnel, or time spent in the treated tunnel during their first visit (P = 0.27 - 0.93) (Table 2).

Black rats displayed exploratory behavior (sniffed, moved their head back and forth, or extended their head and body) during 61% of the observations, groomed themselves during 3% of the observations, and remained stationary (compared to walking, running, or jumping) during 39% of the observations. There was little difference (P = 0.38 - 0.98) between trials, among treatment groups, or between genders in the proportion of time spent performing these behaviors. Sporadic and minimal consumption of coconut precluded analysis of this variable.

Polynesian Rats

Females spent proportionately less time than males (45% versus 51%, respectively) on the treated side of the arena (P = 0.07). Otherwise, we detected no statistically significant differences between trials, among treatment groups, or between gender of Polynesian rats with respect to the percentage of observations spent in various parts of the arena (P = 0.14 - 0.84) (Table 3) or to latency until first emergence into the arena, latency until first entry into the treated tunnel, or time spent in the treated tunnel during the first visit (P = 0.12 - 0.89) (Table 4).

Polynesian rats displayed exploratory behavior during 75% of the observations, groomed themselves during 0.6% of the observations, and were stationary during 40% of the observations. There was little difference (P = 0.22 - 0.78) between trials, among treatment groups, or between genders in the proportion of time spent performing these behaviors. A lack of consumption by most Polynesian rats precluded statistical analysis of this variable.

Field Study

We captured a mean of 49.2 rats per transect during 4 days of trapping (Table 5). Capture success differed between treated and untreated traps depending on trap day (F = 3.60; 3, 24 df; P = 0.028) and on whether traps were treated with mongoose feces or mongoose urine (F = 13.47; 1, 8 df; P = 0.006). Untreated traps captured more ($P < 0.05$) rats than treated traps on days 1 (14.4 versus 8.2 rats, respectively) and 2 (7.5 versus 4.2 rats, respectively), but not on days 3 (5.4 versus 3.2 rats, respectively) and 4 (3.9 versus 2.3 rats, respectively). Traps soiled with mongoose feces captured fewer ($P < 0.05$) rats (2.2) than did traps treated with mongoose urine (6.8 rats) or untreated traps on either the feces transects (8.2 rats) or the urine transects (7.5 rats). Capture success did not vary ($P > 0.05$) among traps treated with mongoose urine and untreated traps. The gender of the mongoose that was the source of the feces or urine had no effect on capture success (F = 1.58; 1, 8 df; P = 0.24).

DISCUSSION

Most rodents are under intense selective pressure to assess and avoid predatory risks (Lima and Dill 1990). By signaling the recent presence of predators in an area, residual predator odors

Table 1. Mean Percentage of Observations (SE in Parentheses) That Black Rats *(Rattus rattus)* Were in Various Locations within a 150- × 60- × 120-cm Stainless Steel Arena during 15-min Trials[a]

Treatment	Trial	% of Observations									
		In Transfer Cage		In Either Tunnel		On Treated Side of Arena		Near Treated Tunnel		In Treated Tunnel	
Water	Pretreatment	45.8	(6.3)	8.0	(2.2)	54.6	(4.8)	18.7	(3.6)	5.6	(2.1)
	Treatment	35.6	(4.8)	7.4	(1.1)	58.0	(3.1)	23.6	(2.3)	4.3	(1.2)
Mongoose Feces	Pretreatment	42.0	(8.3)	8.5	(4.0)	56.5	(6.4)	23.0	(5.5)	2.4	(0.7)
	Treatment	30.7	(7.3)	8.3	(1.7)	47.8	(4.4)	22.6	(3.3)	1.8	(0.6)
Mongoose Urine	Pretreatment	48.5	(5.8)	2.8	(1.1)	56.6	(5.0)	16.0	(1.7)	1.3	(0.5)
	Treatment	54.4	(9.1)	2.9	(0.6)	58.4	(5.4)	14.9	(4.2)	1.1	(0.3)
Butyric Acid	Pretreatment	42.9	(6.5)	5.5	(1.7)	41.7	(2.8)	15.8	(2.7)	2.2	(0.7)
	Treatment	42.7	(8.1)	3.7	(1.5)	53.4	(5.7)	21.2	(7.6)	1.7	(0.7)

[a] Each side of the arena contained a 30- × 10- × 10-cm stainless steel tunnel that enclosed a ceramic bowl with a chunk of coconut. During the treatment trial, one of four treatments (water, mongoose feces, mongoose urine, or butyric acid) was applied to the lip of one of the bowls.

Table 2. **Mean Time (SE in Parentheses) until Black Rats *(Rattus rattus)* (1) Initially Emerged from the Transfer Cage into a 150- × 60- × 120-cm Stainless Steel Arena[a], (2) Initially Entered the Treated Tunnel, and (3) Remained in the Treated Tunnel during Their First Visit**

		Time (sec)					
Treatment	Trial	Emerge from Transfer Cage		Enter Treated Tunnel		Remain in Treated Tunnel	
Water	Pretreatment	44	(17.0)	154	(83.1)	4	(0.9)
	Treatment	29	(8.1)	151	(46.8)	6	(1.3)
Mongoose Feces	Pretreatment	139	(86.7)	208	(83.6)	8	(2.5)
	Treatment	25	(11.1)	128	(52.5)	7	(1.0)
Mongoose Urine	Pretreatment	57	(12.2)	279	(125.0)	5	(0.9)
	Treatment	136	(86.1)	266	(109.4)	8	(1.2)
Butyric Acid	Pretreatment	73	(23.5)	279	(107.1)	22	(15.2)
	Treatment	95	(35.3)	266	(112.8)	7	(2.5)

[a] Each side of the arena contained a 30- × 10- × 10-cm stainless steel tunnel that enclosed a ceramic bowl with a chunk of coconut. During the treatment trial, one of four treatments (water, mongoose feces, mongoose urine, or butyric acid) was applied to the lip of the bowl in the treated tunnel.

may provide an early warning that enables potential prey to avoid fatal encounters with predators. A broad range of rodents avoid predator-derived odors (Epple et al. 1993; Sullivan et al. 1988*a,b*; Coulston et al. 1993; Swihart 1991).

Sulfur-containing compounds derived from predator urine (Swihart 1991, Nolte et al. 1994), feces (Vernet-Maury 1980, Fombon and Polak 1987, Calder and Gorman 1991), or anal glands (Sullivan et al. 1988*a,b*, 1990*a*; Epple et al. 1993) seem to be especially repellent to rodents. The repellency of predator urine to potential prey varies with predator diet (Nolte et al. 1994) and may depend on sulfurous odors associated with digestion of meat (Mason 1993, Nolte et al. 1994). The feces and urine used in both our laboratory and field tests came from captive mongooses that were maintained on a diet of rat carcasses and ground hamburger.

Rats display a variety of defensive behaviors when confronted with predatory threats, depending on the distance to the perceived threat and the availability of escape (Blanchard and Blanchard 1987, Blanchard et al. 1990*a*). Captive wild rats *(R. norvegicus)* exposed to trimethyl thiazoline, a compound derived from fox feces, avoided the immediate surroundings of the odor and visited exposed areas of a terrarium less often (Vernet-Maury et al. 1992). Laboratory rats exposed to a cat in a cage suppressed drinking and froze, with intermittent brief bursts of high-speed activity (Mollenauer et al. 1974). Laboratory rats exposed to a live cat in a seminatural setting initially withdrew into their burrows, suppressed nondefensive behaviors (e.g., eating, drinking, sexual behavior, and aggression), and remained immobile; eventually the rats emerged

Table 3. Mean Percentage of Observations (SE in Parentheses) That Polynesian Rats *(Rattus exulans)* Were in Various Locations within a 150- × 60- × 120-cm Stainless Steel Arena during 15-min Trials[a]

Treatment	Trial	% of Observations									
		In Transfer Cage		In Either Tunnel		On Treated Side of Arena		Near Treated Tunnel		In Treated Tunnel	
Water	Pretreatment	52.9	(7.4)	2.8	(0.8)	40.6	(4.5)	9.2	(2.0)	1.6	(0.6)
	Treatment	47.1	(7.2)	4.0	(1.4)	45.0	(4.1)	11.3	(2.4)	2.5	(0.7)
Mongoose Feces	Pretreatment	45.0	(8.7)	3.1	(1.1)	52.8	(6.4)	13.1	(2.9)	2.0	(0.8)
	Treatment	43.9	(8.7)	3.5	(1.1)	48.4	(3.7)	12.7	(2.6)	1.1	(0.3)
Mongoose Urine	Pretreatment	57.6	(8.3)	1.2	(0.5)	49.1	(3.5)	9.9	(2.6)	0.3	(0.2)
	Treatment	49.2	(9.8)	7.5	(6.2)	51.5	(4.8)	14.6	(6.9)	6.8	(6.1)
Butyric Acid	Pretreatment	48.6	(7.5)	2.6	(0.5)	50.2	(1.8)	10.1	(1.1)	0.6	(0.3)
	Treatment	49.9	(8.1)	1.0	(0.5)	46.5	(3.3)	7.0	(1.2)	0.4	(0.2)

[a] Each side of the arena contained a 30- × 10- × 10-cm stainless steel tunnel that enclosed a ceramic bowl with a chunk of coconut. During the treatment trial, one of four treatments (water, mongoose feces, mongoose urine, or butyric acid) was applied to the lip of one of the bowls.

Table 4. **Mean Time (SE in Parentheses) until Polynesian Rats *(Rattus exulans)* (1) Initially Emerged from the Transfer Cage into a 150- × 60- × 120-cm Stainless Steel Arena, (2) Initially Entered the Treated Tunnel, and (3) Remained in the Treated Tunnel during Their First Visit[a]**

		Time (sec)					
Treatment	Trial	Emerge from Transfer Cage		Enter Treated Tunnel		Remain in Treated Tunnel	
Water	Pretreatment	121	(38.3)	252	(79.8)	8	(2.5)
	Treatment	58	(18.2)	245	(77.4)	17	(5.3)
Mongoose Feces	Pretreatment	62	(19.6)	347	(109.6)	11	(3.4)
	Treatment	88	(27.9)	158	(50.0)	6	(1.9)
Mongoose Urine	Pretreatment	208	(65.8)	461	(145.7)	6	(2.0)
	Treatment	139	(44.0)	495	(156.5)	8	(2.5)
Butyric acid	Pretreatment	59	(18.7)	416	(131.6)	12	(3.9)
	Treatment	52	(16.4)	456	(144.3)	7	(2.2)

[a] Each side of the arena contained a 30- × 10- × 10-cm stainless steel tunnel that enclosed a ceramic bowl with a chunk of coconut. During trial 2, one of four treatments (water, mongoose feces, mongoose urine, or butyric acid) was applied to the lip of the bowl in the treated tunnel.

to explore the surface area and assess predatory risks (Blanchard and Blanchard 1989). Rats exposed to only cat odors elicited higher levels of risk assessment than rats exposed to live cats (Blanchard et al. 1990*b*).

The rats in our laboratory study displayed no evident antipredator behavior to either mongoose feces or urine. Neither black rats nor Polynesian rats froze or took refuge in the transfer cage or the tunnels when confronted with mongoose feces or urine. Nor did they avoid the treated tunnel or the treated side of the arena when it contained mongoose feces or urine. We saw no obvious increase in exploratory behavior (e.g., sniffing, head sweeping) in the presence of mongoose feces or urine.

The predator odors may have diffused throughout the arena during our laboratory tests so that rats could not discriminate their source. Most antipredator behavior occurs in response to highly discernable stimuli (Blanchard and Blanchard 1987). However, the tunnels were at least partially effective in containing the odors because we did not smell the feces or urine unless we were within <30 cm of the treated tunnels.

Unfamiliarity with the arena and laboratory testing regime may have mitigated any effects of the treatments. Rats are reluctant to enter unfamiliar structures (Cowan 1977), and two pretest trials may not have been sufficient to familiarize the rats with the test situation. During the pretreatment trial, black rats and Polynesian rats were in tunnels during only 6% and 2%, respectively, of the observations and were in, on, or near the treated tunnel during only 18% and 11%, respectively, of the observations. This small percentage of time spent in the vicinity of the

Table 5. **Mean Number of Rats (*Rattus* spp.) Captured per Transect in Forested Areas and Around Recently Harvested Sugarcane Fields near Hilo, HI, February–November 1994[a]**

		Day			
Treatment	Trap	1	2	3	4
Female Mongoose Feces	Treated	2.7	1.3	0.7	1.7
	Control	12.7	6.0	4.3	4.0
Male Mongoose Feces	Treated	3.3	2.7	3.3	1.7
	Control	15.0	9.0	7.7	6.7
Female Mongoose Urine	Treated	10.3	5.0	4.0	3.0
	Control	14.3	5.0	2.3	1.3
Male Mongoose Urine	Treated	16.7	7.7	4.7	3.0
	Control	15.7	10.0	7.3	3.7

[a] Each transect contained 50 pairs of wire-mesh cage traps spaced 30 m apart; traps within pairs were spaced 10 m apart. We applied each of 4 treatments to half of the traps in 3 transects (total of 12 transects) by placing 20–25 ml (a heaping tablespoon) of feces or 2 cc of urine of the appropriate gender inside one trap in each pair.

tunnels may have provided too low a baseline for detecting any subsequent decline during the treatment trial.

The discrepancy between our laboratory and field results indicates that rats assessed the threat of mongoose feces differently in these two contexts. Rats probably rely on several cues to detect and assess the threat of predators. Our testing arena was an artificial, simple environment, and rats may have perceived quickly that no mongooses were present. A black rat from a previous study (Tobin, unpubl. data) readily entered the arena when it contained a mongoose constrained in a live trap. Within minutes, the rat ventured behind a wall concealing the trap, sniffed around the trap, and eventually climbed on top of the trap.

Our field results confirm those of a previous study (Tobin et al. 1995) that rats avoid traps soiled by mongooses and that field researchers should replace soiled traps to reduce a source of experimental error. The lack of positive results in the laboratory test indicates that researchers should incorporate relevant factors in the natural environment into laboratory test paradigms and exercise caution when interpreting results of tests with captive animals. Additional research is warranted to determine the active compound(s) in mongoose feces that repel rats, and to explore the use of such compounds to reduce rat damage to agricultural crops.

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